Surface ozone pollution damages rice production in China

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Credit: Earth100/Wikipeidia

High levels of surface ozone are damaging rice yields at an alarming rate in China, the world's largest agricultural producer and one of its most polluted nations, report researchers at the University of California, Davis, and in China.

For the first time, the research team identified a specific stage of the rice plant's development as being vulnerable to ozone pollution, which they warn has the potential to impact the international rice market and compromise global food security.

"As ozone levels increase in China, this form of pollution threatens to not only decrease the nation's rice production but also affect the broad, global rice market," said the study's lead author Colin Carter, a professor of agricultural and resource economics at UC Davis.

"In order to better design regulatory policies that help alleviate ozone pollution and protect China's rice crop, it's essential to develop a better understanding of the complex relationship between ozone and rice production," said Carter, whose research has for many years focused on China's grain markets.

Findings from the new study are reported today in *Nature*'s *Scientific Reports*.

Rice production in China

Rice is China's most important agricultural crop. In 2015, China's rice crop was 206.4 million metric tons, 30 percent of the global crop that year.

Although it is aiming to achieve 95 percent self-sufficiency in rice, China is now the world's largest rice importer and is expected to continue in that position for the next decade.

Around the world, most rice is consumed within the countries where it is grown, leaving only 8 percent of global rice production to be traded internationally in an average year. This causes the price of rice sold on the international market to be extremely sensitive to small changes in

production.

Ozone pollution and rice productivity

Surface ozone refers to the ozone found in the troposphere—Earth's lowest atmospheric layer extending about 20 kilometers, or nearly 12.5 miles, above sea level. This surface ozone lies below "the ozone layer," which occurs in the Earth's stratosphere, or upper atmosphere.

With China's rapid growth and development in recent decades, more vehicles, power plants and refineries have been emitting nitrogen oxides—the chemical building blocks for atmospheric ozone.

For this study, the researchers examined existing air quality data as well as rice yield statistics from the 2006, 2008 and 2010 growing seasons in five provinces of Southeast China.

The researchers designed their model to take into account annual variations such as weather, fertilizer use and natural disasters, which also could impact rice yield. They found that for every additional day when the surface ozone level topped 120 parts per billion, there was a 1.12 percent loss in rice yield, compared to every additional day when surface ozone was less than 60 parts per billion.

"If this level of rice yield reduction occurred throughout all of China, it would lead to the loss of about 2 million metric tons of rice annually, which equals about one-third of China's current annual rice imports," Carter said.

Seasonal timing key to ozone's rice crop damage

Interestingly, the researchers discovered that the harmful effects of

ozone pollution were not the same for every stage of the rice plant's development. In fact, the increased levels of ozone only led to rice yield reductions during the time when the rice plants were forming their "panicles," the flowering spikes at the tip of the rice stalks, where the grain eventually forms.

"This is important because it indicates that regulatory policies can be most effective in protecting rice yields if they address the period of time when rice plants are in the panicle-formation stage of growth," Carter said.

More information: Colin A. Carter et al. Stage-specific, Nonlinear Surface Ozone Damage to Rice Production in China, *Scientific Reports* (2017). DOI: 10.1038/srep44224

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